MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3 , 2018/2019

ERT3026 – AUTOMATION
(RE)

27 MAY 2019
2.30 p.m. – 04.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of **7 pages** including cover page and Appendix with **4 Questions** only.
2. Attempt **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) Design a programmable logic controller (PLC) ladder diagram to control motor and pump to satisfy the following conditions: -

- Press the push button1 and then start the motor.
- After a delay of 60 seconds start a pump.
- Press the push button 2 and then stop the motor.
- After 20 seconds Pump will stop.

[13 marks]

Table Q1-(a) The Input/Output Assignment for Question 1(a)

Input Address	**Input Devices**
0.01	Push Button 1
0.02	Push Button 2
Output Address	**Output Devices**
2.00	Motor
2.01	Pump

(b) Press the start switch. After 1500 seconds, the single acting cylinder will be outstroke. The timer of PLC can be achieved only 999 seconds. Design cascading timers to achieve this requirement.

[9 marks]

(c) Construct the ladder logic diagrams for the NAND logic and NOR logic.

[8 marks]

Continued...

Question 2

A 23-station transfer line has been logged for 5 days (total time = 2400 min). The transfer line performs a sequence of machining operations, the longest of which takes 0.42 min. The transfer mechanism takes 0.08 min to index the parts from one station to the next each cycle.

During these 5 days, there were a total of 158 downtime occurrences on the line. The type of downtime occurrence, number of occurrences for each type and total time lost for each type is shown in **Table Q2**. Assuming no parts removal when the line jams.

Table Q2. Type of Downtime Occurrence for Question 2

Type of downtime	Number of occurrences	Total time lost
Associated with stations:		
Tool-related causes	104	520 min
Mechanical failures	21	189 min
Miscellaneous	7	84 min
Transfer mechanism	26	78 min

Based on the five-day observation period, determine:-

(a) The number of parts produced **[9 marks]**

(b) The downtime proportion **[3 marks]**

(c) The production rate **[5 marks]**

(d) Transfer mechanism breakdown frequency **[3 marks]**

Continued ...

Question 3

(a) A flexible manufacturing system (FMS) is being planned. It has a ladder layout as pictured in **Figure Q3 (a)** and uses a rail guided vehicle (RGV) system to move parts between stations in the layout. All work parts are loaded into the system at station 1, moved to one of three processing stations (2, 3, or 4), and then brought back to station 1 for unloading. RGV move in clockwise direction only.

Once loaded onto its rail guided vehicle, each work part stays onboard the vehicle throughout its time in the FMS. Load and unload times at station 1 are each 1.0 min. Processing times at other stations are: 5.0 min at station 2, 7.0 min at station 3, and 9.0 min at station 4. Hourly production of parts through the system is: 7 parts through station 2, 6 parts through station 3, and 5 parts through station 4.

(i) Develop the From-to-Chart to show flow rates, loads/hr and travel distance between station and layout.

[7 marks]

(ii) Develop the network diagram to show material deliveries between load/unload stations.

[3 marks]

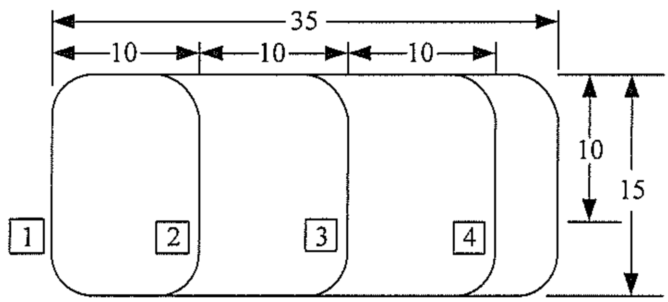

Figure Q3 (a): FMS Layout for Question 3(a)

(b) An overhead conveyor system is used to carry cushion base parts along a manual assembly line. The spacing between appliances is 2.0 m and the speed of conveyor is 1.5 m/min. The length of each workstation is 4.5 m. There are a total of 20 stations and 20 workers on the line.

Determine:

(i) Elapsed time a car cushion base parts spends on the line. **[4 marks]**

(ii) Feed rate and Tolerance time. **[6 marks]**

Continued ...

Question 4

A flexible manufacturing cell (FMC) consists of two machining workstations plus a load/unload station. The load/unload station is station 1. Station 2 performs milling operations and consists of one server (one CNC milling machine). Station 3 has one server that performs drilling (one CNC drill press).

The three stations are connected by a part handling system that has one work carrier. The mean transport time is 2.5 min. The FMC produces three parts, A, B, and C. The part mix fractions and process routings for the three parts are presented in the **Table Q4**. The operation frequency is 1.0 for all operations.
Determine:

(a) Maximum production rate of the FMC **[16 marks]**

(b) Corresponding production rates of each product **[4 marks]**

(c) Utilization of each machine in the system **[5 marks]**

(d) Number of busy servers at each station **[5 marks]**

Table Q4. Part Mix Fractions and Process Routings for Question 4

Product	Part mix p_j	Operation k	Description	Station i	Process time t_{ijk}
A	0.2	1	Load	1	3 min
		2	Mill	2	20 min
		3	Drill	3	12 min
		4	Unload	1	2 min
B	0.3	1	Load	1	3 min
		2	Mill	2	15 min
		3	Drill	3	30 min
		4	Unload	1	2 min
C	0.5	1	Load	1	3 min
		2	Drill	3	14 min
		3	Mill	2	22 min
		4	Unload	1	2 min

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APPENDIX

TABLE 1: Some Useful Formulas

$R_p = \dfrac{1}{T_p}$	$T_c = T_m + T_s$	$T_c = \dfrac{s_p}{v_c}$	$T_t = \dfrac{L_s}{v_c}$
$WL = \dfrac{Q\,T_c}{1-q}$	$n = \dfrac{WL}{AT}$	$n = \dfrac{W}{M}$	$AT = S_w H_{sh} AU$
$T_c \le \dfrac{E}{R_p}$	$E_b = \dfrac{T_{wc}}{n\,T_s}$	$f_p = \dfrac{v_c}{s_p}$	$T_c = Max\{T_m, T_s\} + T_r$
$D = \dfrac{FT_d}{T_p}$	$E = \dfrac{T_c}{T_p}$	$T_s = MaxT_{si} \le T_{mc} - T_r$	
$T_C = T_L + \dfrac{L_d}{v_c} + T_U + \dfrac{L_e}{v_e}$		$T_p = T_c + FT_d$	
$F = \sum_i^n p_i$		$F = 1 - \left[\prod_{i=1}^{n}(1-p_i)\right]$	
$T_{wc} = \sum_{j=1}^{n_e} T_{ej} = \sum_i^n T_{si}$		$d = \dfrac{nT_s - T_{wc}}{nT_s}$	
$WL_i = \sum_j \sum_k t_{ijk}\, f_{ijk}\, p_j$		$n_t = \left(\sum_i \sum_j \sum_k f_{ijk}\, p_j\right) - 1$	
$WL_{n+1} = n_t t_{n+1}$		$BS_i = WL_i\left(R_p^*\right)$	
$R_p^* = \dfrac{S^*}{WL^*}$		$R_{pj}^* = p_j\left(R_p^*\right)$	
$U_i = \dfrac{WL_i}{s_i}\left(R_p^*\right)$		$\overline{U} = \dfrac{\sum_{i+1}^{n+1} U_i}{n+1}$	$\overline{U_s} = \dfrac{\sum_{i+1}^{n+1} s_i U_i}{\sum_{i=1}^{n} s_i}$
$N^* = R_p^* \left(\sum_{i=1}^{n} WL_i + WL_{n+1}\right)$			

TABLE 2: Extended Bottleneck Model

Case 1: N < N*	Case 2: N ≥N*
$MLT_1 = \sum_{i=1}^{n} WL_i + WL_{n+1}$	$R_p^* = \frac{s^*}{WL^*}$
$R_p = \frac{N}{MLT_1}$	$R_{pj}^* = p_j(R_p^*)$
$R_{pj} = p_j R_p$	$MLT_2 = \frac{N}{R_p^*}$
$T_w = 0$	$T_w = MLT_2 - \sum_{i=1}^{n} WL_i + WL_{n+1}$